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BORDEAUX MIXTURE AND ITS USE.

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BORDEAUX.

Bordeaux mixture is the standard means of controlling those fungus diseases which affect the parts of plants above ground. It is a preparation of the solutions of copper sulphate and calcium carbonate (lime) in water. In appearance it is a somewhat flocculent, light-blue liquid, tending to settle when left standing for any length of time; the rapidity of settling being much greater in poorly made than in carefully prepared Bordeaux. Its

Figure 1.—Preparation of Bordeaux mixture.

fungicidal power is due to the copper sulphate present, lime being added to prevent injury to foliage, and to increase the lasting power of the spray on sprayed surfaces.

Solutions of copper salts kill living cells of plants, including fungus spores, which they may touch. When used alone, these solutions are likely to injure the more tender part of the plants. Lime is added to counteract the tendency to "burn" the foliage. "Burning" by Bordeaux is the

result of killing the leaf cells in spots by the action of the copper salt on the cells. Burning does not occur seriously, if at all, when proper care is used in preparation and application of the mixture.

The leaves of peach, and probably Japan plum, having practically no protective waxy coating such as is present on apple and pear, have the power of absorbing solutions of some substances which may be in contact with them. Copper sulphate is absorbed and kills the peach leaf cells quite as surely as if they were fungus spores. Where each particle of copper has a particle of lime with it, the absorption is very much more slow or possibly totally checked, and injury is avoided. This is one reason peach leaves are more easily injured by poorly prepared, or carelessly applied, Bordeaux than are the more hardy apples and pears, and require a weaker preparation. The germinating fungus spore dissolves and absorbs the copper salt of the Bordeaux in such quantities as to kill itself before injuring the plant, *if* the Bordeaux covers the spot when the spore happens to fall.

PREPARATION.

Much time and labor may be saved by the use of stock solutions. A sufficient amount of the stock solutions should be prepared, so that any one application may go on with no delays because of lack of materials. One barrel (50 gallons) will give lime solution enough for eight barrels of spray (six gallons of lime each) with a margin of two gallons for spilling, etc. One barrel (fifty gallons) of copper stock will be enough for twelve barrels of spray (four gallons to each) ; or three barrels of lime stock (150 pounds), and two barrels copper stock (100 pounds) will make twenty-five barrels of spray mixture when properly diluted.

Slake fifty pounds of lime by adding successively small amounts of water until a smooth paste is produced, then dilute to fifty gallons.

Dissolve fifty pounds of copper sulphate in fifty gallons of water by suspending in a sack or closely woven basket just below the surface of the water.

Care should be used to get a high grade of lime, and to slake it thoroughly and smoothly, keeping it covered with water at all times thereafter. It may be convenient to keep the lime in the form of cream-of-lime, rather than in the one pound to one gallon solution. If so, find the number of gallons of water necessary to slake 50 pounds of lime to a cream, and the amount of stone lime in each gallon of the cream, and work as before, keeping the proportions the same (six pounds of lime, four of copper sulphate, fifty gallons of water). Dilute to a whitewash before measuring.

For use take six gallons of lime solutiou well stirred, and dilute to twenty-five gallons, and four gallons of copper solution, dilute to twenty-five gallons, then pour at the same time from both diluted solutions into the spray barrel (see Figure 1).

For apple, pear, and grape, and for field crops, use as above, also for peach and plum before buds start. For peach and plum in leaf use nine gallons of lime and three gallons of copper ; stronger solutions injure foliage.

Strain all solutions used.

TEST.

As lime varies to a considerable degree, it is well to test each lot purchased before applying it as Bordeaux. The test is made by dipping up in a white saucer a little of the freshly made and well-stirred Bordeaux, pre-

pared according to formula and adding a drop or two of a solution of ferrocyanide of potash.* If there is sufficient lime present no change will be seen. But if there is not enough lime present, or if the lime is weak in strength, a brown or reddish color will appear where the drop strikes the Bordeaux. Add more lime slowly to the Bordeaux until no change of color occurs in fresh samples examined. Then add one quart for safety and the whole amount taken will be safe so long as the same stocks are used. This is a guide for apple and other hardy plants. For peaches take three gallons of sulphate and one and one half times as many gallons of lime as was used with apple. This gives with first grade lime three pounds of sulphate, nine pounds (six plus one half of six) lime to the barrel (fifty gallons). The test cannot be applied directly to the spray mixture for peach, as lime must be in great excess (three times greater than sulphate).

Properly made Bordeaux does not settle rapidly while standing, and has a light blue color of a characteristic shade. Bordeaux which is poorly made settles rapidly, is greenish or deep blue, and instead of being uniform in color, is more or less blotched or mottled in appearance, and is less efficient as a fungicide, as it does not remain so long on the sprayed surfaces.

APPLICATION.

The spray mixture being ready to apply, the next step in the work of spraying is to apply it. In the application of sprays, there are two important items to be considered—the pump, and the nozzle. The pump should give a continuous stream under moderate pressure, without excessive labor in pumping. The nozzle should give a fine, **misty spray,** not a shower of drops. The separate small globules of sprayed liquids will remain on the leaf or fruit longer than will those of larger size. It is the part that stays that is beneficial, not that which runs off upon the ground. Large drops run together and drop off much more readily than do small ones. The small globules do not tend to concentrate the solution by the gathering of any considerable amount in a spot. The larger drops, however, may contain a quantity sufficient to injure delicate foliage, when the strength has been increased by evaporation of the water, especially if several drops have run together and accumulated at the margin. The smaller bodies of liquid remain distinct, and no one of them contains an injurious amount of the chemical. In addition to these reasons, the surface is more completely covered, as the fine globules can stand thicker than the larger drops, so that there is less space left for any spores to reach the unprotected surfaces of leaf and fruit.

ITEMS OF COST.

In respect to cost the expense will vary with local conditions—amount and wages of hired help, distance to haul between the mixing station and orchard, nature and abundance of water supply, whether flowing or raised by hand. Freight may be neglected, as it is a relatively small amount, one or at most two days wages usually paying the season's freight bills for

*Obtain from a druggist; dissolve one ounce in eight ounces of water, keep in plainly-marked POISON bottle, with dropping tube through cork, so only one or two drops escape at once. Keep away from inquisitive fingers.

chemicals. The items just mentioned vary with the location to such an extent that it would be misleading to try to estimate them in a bulletin. But the amounts of spray solution required, and the increased yield per acre may be estimated with fairly definite results, and to these items each grower may add his local expenses to find the total cost to him, if he so desires. The expense for apparatus used varies with the outfit; prices are given for the best.

The Pumps*.—Whether hand or power pumps are used, a brass plunger, and valves, and brass lined or all brass cylinder, are essential. The valve should be easily reached for examination and cleaning. All parts in contact with spray solutions should, so far as possible, be brass or copper, as iron and steel tend to cause the copper to separate from the Bordeaux solution, especially if not properly made. Do not get any galvanized iron sprayer, unless you want to buy one every season. **Never use iron or steel vessels in preparing the sulphate solution.** Granite or enameled ware dipping vessels are suitable for handling, but use wooden vessels for dissolving the copper sulphate. For hand work, the Morrill and Morley (Benton Harbor, Mich.) "Eclipse," ($13.00) is probably the best, being the result of years of practical work in improvement in Mr. Morrill's orchards in the Michigan peach belt. The following pumps are also good: Gould Mfg. Co.'s (Seneca Falls, N. Y.) "Pomona," ($15.00), or "Savelot," ($12.50), or the Deming Co.'s (Salem, O.) "Century," ($13.50). The prices are for pumps alone.

For power spraying, as for potatoes, some of the two-wheeled horse power machines are available. Thomas Peppler's (Hightstown, N. J.) "Perfection," ($75.00) is as convenient as any, but has only one nozzle to each row (6 rows). Two lines of hose with nozzles are included as part of the outfit. The Riverhead Agl. Works, (Riverhead, L. I., N. Y.) "Hudson" sprayer has two nozzles, each row, (4 rows) but lacks the wide reach of the first make. By slightly modifying the Peppler, a practically ideal machine would probably result for all work on field plants, so planted that a cart may be driven between rows or belts of rows. See also fig. 2 on last page.

SUGGESTIONS.

Others have found profit in spraying, by doing their work carefully, thoroughly and frequently enough to be effective. Why can not you also? And this profit was received even in the absence of serious blights or diseases which may have destroyed the crops if unsprayed; the quality being improved by spraying to such an extent as to more than balance the extra expense. But spraying will not replace cultivation, or other care of crops; it is an aid to good crops in addition to these customary methods. Spraying is, in effect, a means of insurance taken by the growers to enable them to bring to perfect maturity the crop which the plants, under cultivation and other care, are able to produce.

When you spray field crops, leave a portion, one row or several, unsprayed, and keep a record of their yield distinct from the rest (sprayed) of the field, and compare the yield of same number of rows sprayed and un-

*Griffith & Turner, Baltimore, Md., handle most of these, as well as other makes. Correspondence with them or with this Department will receive prompt attention.

sprayed. This will enable you and your neighbors to see just what good spraying does. Do the same in your orchard, and then you will be able to answer for yourself from your own experience, the question : Does spraying pay?

In planting melons, etc., so plant them that a team can be driven through without injury to vines every 20 feet. This will allow the spraying of the plants for ten feet on each side of the road, by the regular barrel orchard outfit, men guiding the nozzles over the plants. By extending the pipes horizontally, ten feet on each side of cart, it could be distributed by the team, as for potatoes. The pipe would need to be supported by wires and be jointed, to allow passing through gates, etc. Enough nozzles should be used to thoroughly cover the vines.

EXPENSES.

Potatoes represent one of the field crops to be sprayed. Experiments by the New York Experiment Station, conducted on Long Island under conditions nearly comparable to those on the Eastern Shore of Maryland, show marked benefit from spraying, even where no blight was prevalent. Using a sprayer to apply Bordeaux and Paris green to four rows at once, it was found that there was a gain in yield of twenty-five bushels per acre when sprayed five times. This was when applied at the rate of two barrels per acre. More recent experiments have shown an increase as favorable, this increase being greater where the number of applications is larger, of course depending on the thoroughness of the application made at the several sprayings. The expenses for the spray chemicals on the above basis of two barrels per acre is :

Water, 100 gallons	$0.00
Copper Sulphate, 8 pounds, at 5½ cents	.44
Lime, 12 pounds, at 1 cent	.12
Paris Green, one-half pound, at 18 cents	.09
Cost of materials, per acre	$0.65

The prices given above are on a wholesale basis, as when purchased in barrels or 100 pound lots; retail prices may increase by one-half or to 99 cents per acre. No estimate of cost for labor and time is possible in a general circular such as this.

Five applications were found profitable in the Long Island experiments, and at the rate mentioned (65 cents per acre) would give a total expense per acre of $3.25 for the season's materials when used at the rate of two barrels per acre at each application. The increased yield of twenty-five bushels at 25 cents would leave a net profit of $2.90 per acre, but potatoes are not often sold for so low a price, hence the profits would be greater than this, on the same basis of expenses.

The amount actually used should in any case be proportionate to the size of the plants ; less being required for the first application when six or eight inches high, or on dormant fruit trees, than for later ones when the plants are very much larger, or in full leaf. This applies to applications made by hand-guided nozzles. Stationary nozzles on power sprayers use a

constant amount, but by shutting off one of each pair at the first spraying, a corresponding decrease in quantity is made. Each row should have two nozzles set a little apart, and at an angle to each other, so as to spray all the leaves, a vertical spray often leaving a considerable amount unprotected, on account of the upper leaves shielding the lower from the spray mixture.

PROFITS.

The profit in the case of cucumbers was over $250.00 per acre; the crop sold in the Brooklyn market. This may be very extreme, owing to excessive abundance of disease in the vicinity killing practically all unsprayed plants in mid-season. But allowing four-fifths of the profits to be due to these causes, a profit of $50.00 per acre would remain, which is a fair return; the crop yielded nearly 75,000 cucumbers per acre, more than the unsprayed vines.

For orchard trees two gallons is a fair estimate for each application, to a tree 15 feet high and of equal spread. This would average 25 trees for each barrel of spray, at an expense for materials, as before, of 65 cents, when Paris green is used with the Bordeaux, as for codling moth, canker worm, caterpillers, etc., or of fifty-six cents if Bordeaux only is used (4–6–50 formula). This is at the rate of about 5 cents per tree for each spraying, or 25 cents if five applications per season are made. Even in an "apple year," one could realize more than that extra, by spraying, on account of superior quality and color. A reputation for growing prime fruit may be built up and maintained by careful spraying.

TIMES OF SPRAYING.

First Application.—Cover the trees with a carefully applied *fine spray* of clear sulphate solution, or full strength Bordeaux before the buds start. This kills many of the hold-over spores and enables the tree to start fair. It is especially valuable against leaf curl and rot of peach, scab and rot of apple, and rot and mildew of grape.

Second Application.—Immediately after the flowers fall, adding one-fourth pound of Paris green to each barrel to control insects. For potatoes and cucumbers this should be the regular spray, for melons and tomatoes the poison may be omitted, except when needed especially.

Third Application.—When the fruit is the size of cherries, use poison also, if the insects are troublesome. Keep the spray fine, and the nozzle moving.

Fourth Application.—When the fruit is nearly grown, spray again. This will check the ripe rots, and by using soda Bordeaux * it will not show seriously.

With asparagus, cabbage, etc., add one-half gallon resin solution † to the barrel of Bordeaux to help the spray to stick.

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* Soda (Lewis Lye) 1 lb., lime 5 oz., sulphate 3 lbs., water 50 gals. Dissolve lye in hot water, dilute to 10 gals., add to diluted 10 gals. lime solution. Dilute sulphate to 20 gals., mix the two solutions as for regular Bordeanx, fill up to 50 gals.

† Resin solution for use on waxy plants (asparagus, cabbage, etc.): A—Resin, five pounds; fish oil, one pint; water, four and one-half gallons. B—Potash lye, one can; water, one-half gallon. Boil A until resin is thoroughly dissolved; add B very slowly—a little at a time; then boil until a clear, yellowish solution is formed when added to cold water; use one-half to one gallon to barrel of Bordeaux.

SUBSTITUTES FOR BORDEAUX.

Most of the experiments which have been performed with full records and care of details, have been with freshly made Bordeaux. There are a number of patented or ready made preparations on the market that claim more more or less advantage over the regular mixture. No one of these is known to be any better than Bordeaux, but a number have been tested and found to be distinctly poorer.

It hardly needs to be said that if the patented or prepared Bordeaux is as cheap or cheaper than the regular form it would not be manufactured.

The labor of mixing the dry or paste preparations is often much greater than is the case with Bordeaux.

By the use of stock solutions of the spray materials as already described, little delay is experienced in getting ready for any spray work.

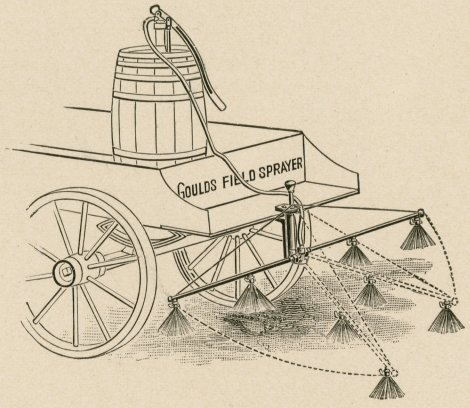

Figure 2.—Gould Mfg. Co.'s Field Spraying attachment for regular spray pumps; dotted lines show position for narrow rows or gateways. Price with coupling for pump, $10.00.